Midterm Exam #1 (Version B)
CS 122A
Spring 2019

Max. Points: 100
(Please read the instructions carefully)

Instructions:
- The total time for the exam is 50 minutes; be sure to budget your time accordingly.
- The exam is closed book and closed notes but “open cheat sheet”.
- Read each question first, in its entirety, and then carefully answer each part of the question.
- If you don’t understand something, ask one of the exam proctors for clarification.
- If you still find ambiguities in a question, note the interpretation you are taking.

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<th>QUESTION</th>
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<th>POINTS</th>
<th>SCORE</th>
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<td>30</td>
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<td>TOTAL</td>
<td>All</td>
<td>100</td>
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Question 1: Modeling Terms (10 points)

(10 pts) You’ve been hired by the Research Division of UCI as an IT intern. On your first day on the job, you are told the following about the data for a project management database that they want to develop:

- Projects have a unique project number, a unique project name, a sponsor name (e.g., NIH), a start date, possibly an end date, and a budget.
- Departments have a department number, a department name, and a main office.
- Departments have a professor (known as the chair) who runs the department.
- Graduate students have a unique social security number, a person name (first, middle, last), an e-mail address, an age, and a degree program (e.g., MS or PhD).
- Professors have a unique social security number, a person name (first, middle, last), an e-mail address, a rank, and one or more research specialties.
- Professors are appointed as members of one or more departments, and for each department in which they hold an appointment, there is a percent time associated with the appointment.
- Each project is managed by exactly one professor (the project’s principal investigator).
- Each project is worked on by zero or more other professors (the project’s co-investigators).
- Professors can manage and/or work on multiple projects.
- Each project is assisted by zero or more graduate students (known as its research assistants).
- When a graduate student assists with a project, his/her assistance work on that particular project is always supervised by some professor. Graduate students may assist multiple projects, in which case he/she will have a (potentially different) supervisor for each one.

Match each of the modeling constructs in the left column below with their best-matching feature (drawn from the description above) in a good E-R design in the right column below. Indicate your answer by writing the relevant description feature in the blank to the left of each modeling construct. (Note: You are permitted to use each feature ONLY ONCE! Also, you may find it bit easier to go down the list of features looking for constructs rather than going down the list of constructs looking for features.)

<table>
<thead>
<tr>
<th>Modeling construct</th>
<th>Description feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ternary relationship</td>
<td>project number, project name</td>
</tr>
<tr>
<td>Entity</td>
<td>assists</td>
</tr>
<tr>
<td>Inherited attribute</td>
<td>percent time</td>
</tr>
<tr>
<td>Optional attribute</td>
<td>student age</td>
</tr>
<tr>
<td>Relationship attribute</td>
<td>social security number</td>
</tr>
<tr>
<td>Multivalued attribute</td>
<td>person name</td>
</tr>
<tr>
<td>Atomic attribute</td>
<td>project end date</td>
</tr>
<tr>
<td>Candidate key</td>
<td>department</td>
</tr>
<tr>
<td>Composite attribute</td>
<td>research specialty</td>
</tr>
<tr>
<td>Super key</td>
<td>e-mail address</td>
</tr>
</tbody>
</table>
**Question 2: Relational Design Theory (25 points)**

Answer each of the following questions about relational DB design and functional dependencies:

(7 pts) Consider a table $T(a, b, c, d, e)$ with FDs $d,c \rightarrow e$, $b \rightarrow c$, $a \rightarrow b$.

a. List the candidate keys for $T$: ______________________

b. Compute the attribute closure ($b^+$) of the attribute $b$: _________________________

c. Circle the highest normal form that $T$ satisfies: BCNF 3NF 2NF 1NF

(10 pts) Assuming that a (possibly different) table $T(a, b, c, d, e)$ currently contains the following data values, answer the following questions about $T$’s set of functional dependencies.

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LP</td>
<td>Congas</td>
<td>3</td>
<td>500</td>
</tr>
<tr>
<td>2</td>
<td>Epiphone</td>
<td>Bass</td>
<td>5</td>
<td>150</td>
</tr>
<tr>
<td>3</td>
<td>PRS</td>
<td>Bass</td>
<td>4</td>
<td>150</td>
</tr>
<tr>
<td>4</td>
<td>Epiphone</td>
<td>Guitar</td>
<td>6</td>
<td>150</td>
</tr>
<tr>
<td>5</td>
<td>Kimball</td>
<td>Piano</td>
<td>80</td>
<td>895</td>
</tr>
<tr>
<td>6</td>
<td>Epiphone</td>
<td>Guitar</td>
<td>6</td>
<td>150</td>
</tr>
<tr>
<td>7</td>
<td>Bundy</td>
<td>Sax</td>
<td>23</td>
<td>350</td>
</tr>
</tbody>
</table>

a. Based on seeing $T$’s content, can we infer that $a$ is a candidate key? NO YES

b. Is it possible that this is the same table $T$ from the first problem above? NO YES

c. Does the functional dependency $d \rightarrow e$ currently hold in $T$? NO YES

d. Does the functional dependency $b,c \rightarrow d$ currently hold in $T$? NO YES

e. Identify a tuple in $T$ that could be deleted to enforce the functional dependency $c \rightarrow d$ (i.e., if this tuple were deleted, the functional dependency would hold in the resulting version of $T$): __________________________

(8 pts) Consider a (possibly still different!) table $T(a, b, c, d, e)$ with FDs $d \rightarrow c$, $a,b \rightarrow e,d$.

a. Circle the highest normal form that $T$ satisfies: BCNF 3NF 2NF 1NF

b. Normalize $T$ into a lossless-join, dependency-preserving 3NF design ($T_1, T_2, \ldots$). List the resulting tables and their corresponding candidate keys:

c. Is your 3NF design also in BCNF? NO YES
Question 3: E-R to Relational Translation (35 points)

(35 pts) Translate the following E-R schema into an appropriate set of SQL tables. As usual, avoid using more tables than necessary, and be sure that your translated design – expressed as CREATE TABLE statements in SQL – includes any/all appropriate (i) primary keys, (ii) unique keys, (iii) NOT NULL constraints, (iv) FOREIGN KEY constraints, and (v) ON DELETE options. Use your best judgement to pick data types. We’ve started the answer for you below, providing the full answer for Article and part of the answer for Table. Finish filling in the details of Table in the space on the left, adding any missing attributes and/or constraints, and then finish the job by adding any/all additional CREATE TABLE statements in the space on the right below. **Note:** Your answer should be able to fit on this page. (If the space on this page is not enough, you may use the blank page at the end of this exam to continue your answer – but that should not be necessary.)

```sql
CREATE TABLE Article (
    doi VARCHAR(60),
    title VARCHAR(90) NOT NULL,
    pages INT,
    date DATE NOT NULL,
    PRIMARY KEY(doi)
);

CREATE TABLE Table (
    tabno INT,
    header VARCHAR(80),
);
```

--- SQL DDL syntax reminder:
CREATE TABLE FooTable (
    fid INTEGER,
    fname VARCHAR(40),
    fprice DECIMAL(8,2),
    doi INTEGER NOT NULL,
    PRIMARY KEY(fid),
    UNIQUE(fname),
    FOREIGN KEY (fid) REFERENCES BarTable (bid) ON DELETE CASCADE
);
Question 4: E-R Modeling (30 points)

(30 pts) Based only on the E-R model pictured at the bottom of this page, indicate whether each of the following statements are true (T) or false (F) by writing the appropriate letter in the space to the left of the statement.

____ A student may have two emails.
____ A professor must write at least one article ("publish or perish", as the saying goes).
____ Each article must have multiple writers.
____ A given article may or may not have a page count (pgcnt).
____ A table must always be included in some article.
____ For a given article that they write, a person has a unique writer number (writerno).
____ A professor may advise multiple students.
____ A student can be co-advised by two or more professors.
____ An article may include no tables.
____ A given table may be included in two or more articles.
____ It is possible to have two articles with the same title.
____ A table can be uniquely identified by its table number (tabno).
____ It is possible for an author to have both a level and a major.
____ Every article must have a student among its writers.
____ Every author must be a student or a professor.